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PROJECT [redacted] PROGRAM

1. Description of Basic Experimental Setup

The photosensitive dipole suspension contains (a) photo-ions; or (b) photo dipoles. Window 2 is quartz or silica laminated with [redacted] transparent conductive coating 3013. Window 3 is glass, laminated with the MPC transparent conductive coating 3013.



The window 2 passes ultraviolet light into the photo-sensitive dipole suspension 1.

The ultraviolet light is supplied by an ultraviolet projector 11 which may be one of three types:

1. High pressure mercury lamp
2. Xenon flash
3. Photoflash bulb

The flash lamp 11 is pulsed by control circuit 5.

Ultraviolet band pass filter 16 transmits ultraviolet light and absorbs visible light. A quartz or silica lens 21 transmits ultraviolet light, and is used to focus an image from plate 20 onto the electrosensitive dipole suspension. For certain experiments the image plate 20 may be removed so that the entire field of the VARAD cell is illuminated uniformly. The plate 20 may have a design such as a number of holes or a letter such as "x" punched into a thin metal plate. This design is imaged upon the plane of the suspension. Mechanical shutter 19 is a standard photographic shutter mechanism. A lamp 10 emits visible light, the intensity of which is maintained constant by a constant voltage transformer 15. Ultraviolet absorption filter 17 and 18 pass visible infrared light.

The effect of the filters is that the cell is illuminated by ultraviolet light only from source 11 and by visible light only from source 10. Only visible light passes through the filter 17. The photocell 12 thus senses a change in the transmission of visible light as influenced by the addition of ultraviolet light. The ultraviolet light itself cannot pass through to the photocell 12 because it is blocked by filter 17.

In investigating the effect of photo-ions, a steady DC biasing voltage is applied via terminals 27 to the transparent conductive coatings in sheets 2 and 3 and a pulse of UV light impinged on the layer 1. The ions produced will separate in the electric field. Isolating resistors 25 and 26 enable a square DC pulse to be applied to the transparent conductive coatings from terminals 24 through capacitors 22 and 23. The current pulse to the cell is measured across known resistor 30 by a CRT scope. The pulsing of the UV light and the square wave DC can be repetitive. If a single pulse is employed 31 must then be a Memoscope.

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## II Experimental Investigations

Arrange to radiate the cell 1 with a pulse of ultra-violet light. This pulse could be provided from:

(a) A flash bulb

(b) A Xenon flash source

(c) An ultraviolet light provided with a camera shutter.

Photo-ions may comprise fluid or solute molecules, which when illuminated by ultraviolet light produce the positive and negative ions from molecules originally neutral. Under the applied DC field these migrate to opposite faces of the cell walls close to the transparent conductors.

The separation of the ions is detected by a pulse of current which can be measured as a voltage pulse across resistor 30; the isolating resistors 25 and 26 maintain a DC biasing voltage across the cell 1 if required.

From a preceding analysis, the energy content of the ultra-violet light pulse required to produce photo-ions which shield an applied electric field of given intensity is known. A square wave DC pulse can be triggered by the light pulse and applied to the cell 1 at the same time. As the ions pass through the layer toward the transparent conductors, the electric field intensity across the dipole layer decreases.

Experiments are to be initially made to detect voltage pulses produced across the resistor 30 using a biasing voltage 27 pulse impinged on the cell 1, without dipoles in suspension, using photo-ion solvents or solutions containing photo-ionic solutes. Then the effect of adding the dipoles on visible light transmittance will be observed.

A photocell can be used to trigger the circuit so that the voltage can be applied to the VARAD cell at the same time that the ultraviolet light pulse arrives. A second photocell 12 which is used to measure the intensity of the visible light beam may alternatively be connected to the log amplifier circuit and then to the Memoscope to detect and to show rapid variations in the intensity of the visible light beam due to changes in dipole alignment caused by the ultraviolet pulse.

## Photo-Responsive Dipolar Suspensions

Photo-responsive dipolar suspensions may be: (a) dipoles in a fluid containing photo-ions produced by ultraviolet light; and (b) photo-dipoles whose conductivity or potential difference changes in ultraviolet light.

(a) The dipoles employed with the photo-ions may be of three types:

(1) A dielectric or non-conducting dipole which may for example, include lead carbonate platelets;

(2) A metallic dipole; and

(3) A herapathite dipole containing polyiodide chains.

(b) The photo-dipole may be of two types:

(1) A semi-conducting needle, for example, silicon or germanium; and

(2) Photo-voltaic whiskers which develop their own potential difference along the needles when excited by ultra-violet light. Zinc sulphide whiskers are an example.

Silicon needles become more conducting when actuated by the ultraviolet light, while the zinc sulphide becomes conducting and photo voltaic as well.

In a photo-ionic dipolar suspension, when the ultraviolet light pulse arrives, in the presence of an electric field, positive and negative ions are produced within the fluid, the metallic dipoles take on induced positive and negative charges at opposite ends, and the photo-ions move to neutralize the charged ends of the dipole. An electric current passes through the dipole as the ions discharge the ends of the dipoles. Photo-ions will decrease in number and, therefore, fewer will be available to travel to the opposite faces of the VARAD cell to neutralize the electric field.

Thus the presence of metallic dipoles will have an effect similar to that of increasing the recombination rate of the dipoles and will tend to reduce the magnitude of the shielding effect. This effect will tend to become more pronounced for high concentrations of dipoles. In dilute suspensions where the dipoles are far apart, there will be less tendency for this effect to occur. At the same time the discharge of the charged ends of the dipole will decrease the turning torque which is equivalent to the shielding effect. However, this involves internal energy losses which may be objectionable.

On the other hand, with dielectric dipoles, no current passes through the dipoles. Therefore, the photo-ions will be available to neutralize the dipolar induced potential and will tend to prevent the dipoles from reacting with the electric field. With dielectric dipoles it may not be necessary to depend upon the shielding of the internal electric field at the faces of the VARAD Panel but the shielding will occur on the induced charges of the dipoles themselves by the attachment of available local photo-ions. This would produce a more rapid and complete shielding.

There will be an upper limiting frequency to dipole ion shielding effect because the mobility of the ions is small, and the AC field reversal can be so rapid that the ions cannot move towards and away from the dipole ends quickly enough to shield effectively.

Investigate a dipole suspension and photo-ion layer as separate layers separated by a thin glass sheet. Under these circumstances, the separation of the photo-ions will cause an increase in the electric field and the dipoles in dipole layer will increase their orientation. There will be an augmentation rather than a decrease in orientation.

Investigate the time required for the electric field in the dipole layer to be shielded by the photo-ions. Make this commensurate with the time required for the dipoles to orient or disorient. This effect is obviously tied in with the magnitude of the electric field, the viscosity of the fluid, the size of the dipoles and the mobilities of the photo-ions produced.

The photo-ions must not react with dipoles species such as the herapathite dipoles, leading to change in the electro-optical properties, chemical deterioration, or fatigue.

When photo-ions are neutralized by contact with metallic dipoles by the flow of the current through the dipoles, we must be concerned with the liberation of electro-chemical products within the dipole suspension; for example, such products as HCL, hydrogen or chlorine gas. Any irreversible reaction will cause fatiguing or destruction of the suspension, liberation of free gases within the layer, or a change in the chemical composition.

Accordingly, a study should be made of reversible photo-ions in a dipole suspension. Determine the conditions under which photo-ions will be reversible.

For light amplifiers or blocking screens, the reversibility is an absolute must. For other uses such as a dipolar paper, it is sufficient that the process operate either once or only a few times.

## III Mathematical-Physics Studies

After we have made a preliminary exploration of these various effects, we should subject the most promising phenomenon to mathematical analysis involving all these factors, deriving the differential equations and solving them to determine the optimum parameters.

A mathematical-physics analysis of these phenomena should be set up.

Theoretical calculations should take into consideration such factors as the mobilities of the ionic particles, the thickness of the cell, amplitude and time duration of the applied voltage pulse, the intensity and time duration of the ultraviolet pulse, dipole characteristics, and other factors.

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EXP 1

BASIC
EXPERIMENTAL SETUP